VTT Technical Research Centre of Finland

DronIce

Berglund, Robin; Seitsonen, Lauri

Published: 01/05/2019

Document Version
Publisher's final version

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DronIce - Using Drones to Support Icebreaker Operations in the Baltic Sea

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DronIce[1)] - Using Drones to Support Icebreaker Operations in the Baltic Sea

Berglund R., Seitsonen L.

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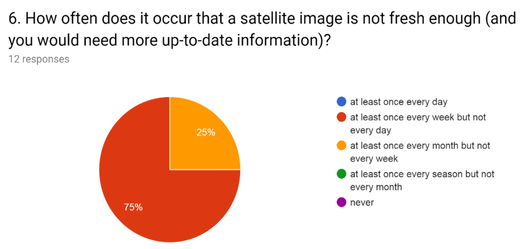
Background

The Baltic Sea has a seasonal ice cover which affects shipping to the northernmost ports for up to 5 months per year. Icebreakers, as part of the Baltic winter navigation system, enable an all-year maritime transportation. The icebreakers get Sentinel-1 images in near-real-time and these images are visualized in their IBNet information system. Ice conditions can be assessed from the satellite images, but the hypothesis is that ice drift and ambiguities in the interpretation are best resolved by airborne imagery. The question is – could drones provide valuable information for the icebreakers and how?

User Needs

A questionnaire was formulated and sent to all Finnish and Swedish icebreaker masters. Here are some highlights of the responses:



This answer indicates that most users indeed experience an information gap occuring every week because of outdated satellite images

Drones could be useful in mainly two situations

- When icebreaker is idling, supervising ships
- In tactical navigation – to find the easiest way through the ice

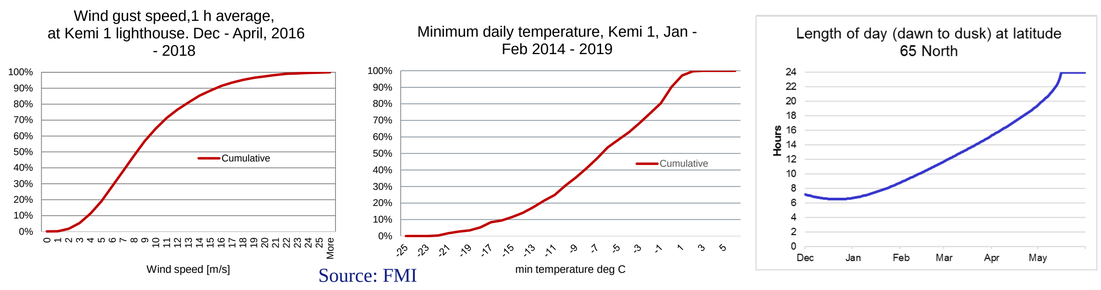
When asking about the most important roles of a drone, the following answers got the highest scores:

- To assess the ice drift since the latest satellite image
- To check the situation at channel inlets (drift ice/fast ice boundary)
- To verify position of awkward channel curves or ice floes
- To document performance problems of assisted ships for quality assurance

The users estimated potential savings to be 4 - 25 k€/mth/IB

Environmental conditions

The icebreakers operate mainly in the northern part of the Baltic Sea. Wind, temperature and length of day at the Kemi 1 lighthouse are shown in the figures below:



Source: FMI

Taking the Kemi 1 lighthouse as an example, 88% of the time, gust wind speed is below 15 m/s. 86% of the days are warmer than –15 ˚C. The length of the day limits the usability of optical cameras in January and February.

The image to the left shows an ice ridge with a processed grid overlaid. 3D processing is done with Agisoft Metascape using tens of images Courtesy of Jonni Lehtoranta, FMI

Types of drones

To the left is shown a tethered helikite (Allsopp UK). The middle picture is a hybrid powered multirotor drone and to the right a VTOL fixed wing drone

- A tethered drone/balloon: for continuous look-out
- A long range hybrid multirotor drone: most versatile
- A fixed wing drone with VTOL capability: an interesting alternative

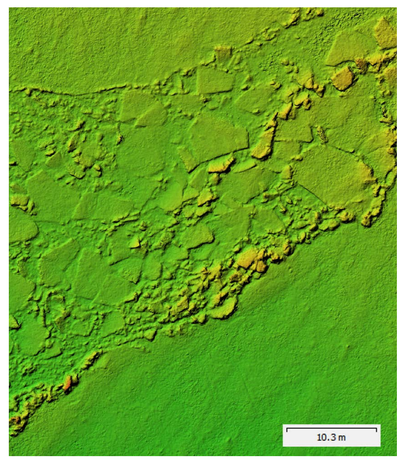
Sensors

Sensor	Purpose	Advantages	Disadvantages
Videocamera	For real-time monitoring	+ inexpensive + useful for guidance	- No quantification of distances or heights - requires full time monitoring of flight - if used for FPV, a separate observer is required.
Optical camera	For accurate imaging	+ standard equipment, thus low-cost + enables photogrammetric processing	- cannot be used in low light conditions - photogrammetric processing takes time
Thermal camera	To enable imaging during low light conditions	+ if ambient temperature is low, open water and thin ice can be seen well. + less sensitive to foggy conditions	- lower resolution than optical cameras - more expensive than optical cameras - requires temperature differences to distinguish features
LiDAR	To obtain a point cloud from which ridge height and surface roughness can be determined	+ a relatively fast way of obtaining surface topology information + LiDAR instruments are available for drone use with a mass of less than 1 kg. + works well at night and low light conditions + technology is advancing fast driven by the interest to develop self-driving cars	- quite expensive - to obtain reflections from ice and open water may be a problem (i.e. low reflection coefficient)

Visualisation

- Colouring based on 3D information could be used to help users evaluate size of ridges etc.
- False coloured thermal ímages for identification of leads in low light conditions

The image to the right shows a lead with colouring based on height data. Courtesy of Jonni Lehtoranta, FMI



Roadmap

2019 - 2021	2022 - 2025	2026 - 2030
• LOS flights mainly • Flight times typically 1 h • First onboard preprocessing trials (edge computing)	• Use of 5G radio • BVLOS flight with UTM (UAS Traffic Management. • Flight permission using app • Arctic grade drones • Fuel cells • Edge computing	• Autonomous drones scanning areas of interest • Information integration with ice information system

VTT – beyond the obvious

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Contact
Robin Berglund
Tel. +358 40 510 2318
firstname.lastname@vtt.fi

1) DronIce is a feasibility study funded by the Finnish-Swedish Board of Winter navigation